AN ANALYSIS OF FATAL EVENTS IN THE CONSTRUCTION INDUSTRY 1997

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For eLCOSH, box for first page of Schriver study:

This study covers only deaths inspected by OSHA and included in its national database. Excluded are self-employed workers and homicides. According to the U.S. Bureau of Labor Statistics, there were 1,195 work-related deaths in construction in 1998

I. **Introduction**

This paper reports on the analysis of fatal events in the construction industry which occurred in calendar year 1997. Four earlier studies[1] by Construction Resources Analysis (CRA) analyzed the causes of fatal events in this industry in 1991-1992, 1993-1994, 1995, and in 1996.

II. **Data**

The data analyzed in this report, provided by OSHA, consist of narrative descriptions of the 604 fatal events resulting from accidents which occurred in construction during calendar year 1997. As in the earlier studies, fatal events included in the OSHA data which resulted from heart attacks, fainting, etc., when not caused by the construction activity, were omitted from the analysis; this resulted in the omission of 25 records in 1997. Although the Occupational Safety and Health Act of 1970 requires employers to report fatalities to OSHA within eight hours of the occurrence of the event, all records were not available at the time of writing (it is estimated that 98 percent of the fatal event records were in the data base analyzed), so the results reported upon here do not allow a year-to-year analysis of changes in the absolute number of fatal events.

Each narrative record consists of a brief description of the event leading to the fatality. The event descriptions were read by the three authors and each was classified into

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[1] An Analysis of Fatal Events in the Construction Industry. 1991-1992 (1993), An-Analysis of Fatal Events in the Construction Industry. 1993-1994 (1995), An Analysis of Fatal Events in the Construction Industry, 1995 (1996), and An Analysis of Fatal Events in the Construction Industry. 1996 (1997). Construction Resources Analysis, University of Tennessee, Knoxville.

one of 29 causative categories. The narrative descriptions varied greatly in clarity and thoroughness, so when the authors could not agree on the cause of an event the event was classified as "other/unknown". Some of the narratives provided thorough descriptions of the actions leading to the fatality, but many were so brief and lacking in detail that it was difficult to extract a specific cause.

In this analysis the authors originally planned to classify each fatal event according to: (1) type of construction (new or addition, alteration or rehabilitation, maintenance or repair, demolition, other); (2) estimate of total project value (seven dollar-value categories beginning with "under $50,000" and ending with 120,000,000 and over"); (3) 17 end-use categories, such as "single-family housing, multi-family building, " "commercial building, 19street or highway," etc.; and (4) the construction operation being performed that caused the fatal event (a list of 71 construction operations such as "backfilling and compacting," “cutting concrete pavement," "erecting structural steel," "installing equipment (HVAC and other," etc.). Lists of these variables and their definitions were provided to OSHA by CRA, and coding for them was subsequently required in an IMIS screen for each fatal construction event inspected by OSHA. However, CRA's review of these data revealed that coded data for an event were often internally inconsistent and often did not comport with corresponding narrative descriptions. Consequently, it was determined by OSHA and CRA that the poor quality of the coded data precluded its inclusion in this report. The data analyzed in this report, therefore, are restricted to the narrative descriptions of the fatal events where the authors were able, in most cases, to classify the events with moderate certainty according to 29 types of causes, essentially the same types as were used in CRA's previous fatality studies. (See Table 1.)

Table 1. Construction Fatality Event Causes, 1997

Event Causes	Description	Number	Percent
1.	asphyxiation/inhalation of toxic vapor	10	1.7
2.	caught in stationary equipment	4	0.7
3.	collapse of structure	24	4.0
4.	crushed/run-over of non-operator by operating construction equipment	49	8.1
5.	crushed/run-over/trapped of operator by operating construction equipment	23	3.8
6.	crushed/run-over by construction equipment during maintenance/modification	12	2.0
7.	crushed/run-over by highway vehicle	20	3.3
8.	drown, non-lethal fall	3	0.5
9.	electric shock by touching exposed wire	20	3.3
10.	electric shock by equipment contacting power source	46	7.6

		Number	Percent
a.	ladder	6	1.0
b.	scaffold	0.0	0.0
c.	crane/lifting equipment/boom/ dump truck	30	5.0
d.	contact while handling materials such as gutters, iron rods, etc.	10	1.6
		46	7.6

11.	electric shock from equipment installation/tool use	26	4.3
12.	electric shock, other	3	0.5
13.	elevator (struck/crushed by elevator or counter weights)	3	0.5
14.	all from/with ladder: includes collapse/fall of ladder.	32	5.3

		Number	Percent
a.	fall from roof	24	4.0
b.	fall with	8	1.3
		32	5.3

15.	fall from/through roof	72	11.9

	Number	Percent
a. fall from roof	39	6.4
b. fall through roof	33	5.5
	72	11.9

16.	fall from highway vehicle/construction equipment	4	0.7
17.	fall from/with scaffold	24	4.0

	Number	Percent
a. from	16	2.6
b. with	8	1.4
	24	4.0

18.	fall from/with bucket (aerial lift/basket)	6	1.0

	Number	Percent
a. from	2	0.3
b. with	4	0.7
	6	1.0

19.	fall from/with structure (other than roof)	55	9.1

	Number	Percent
a. fall from	44	7.3
b. fall with	11	1.8
	55	9.1

20.	fall from/with platform	18	3.0

	Number	Percent
a. fall from	5	0.8
b. fall with	13	2.2
	18	3.0

21.	fall through opening (other than roof)	18	3.0
22.	fall, other	8	1.3

23.	fire/explosion/scalding	16	2.6
24.	hyperthermia/hypothermia	2	0.3
25.	lifting operation	33	5.5
26.	struck by falling object/projectile	19	3.1
27.	trench collapse	25	4.1
28.	unloading-loading equipment/material (except by crane)	12	2.0
29	other/unknown	17	2.8

	Number	Percent
a. lightning	6	1.0
b. crushed	7	1.1
c. other/unknown	4	0.7
	17	2.8
	604	100.0

In classifying the events a rule of primacy was followed for multiple-cause fatalities (representing less than 2 percent of the fatality events in this study and the earlier studies cited): the first cause in the chain of causes was recorded as the cause of the fatal event. Definitions of the causes are shown in Appendix A.

III. **Analysis**

A. Distribution of Fatal Events by Cause

Table I shows the cause classification system, the number of times each cause represented a fatal event in 1997 and the relative frequency of each cause. It can be seen that "fall from/through roof' led all other causes in number of fatal events (72 or 11.9 percent of total fatal events), followed by "fall from/with structure (other than roof)" (55 or 9.1 percent). The third leading cause was "crushed/run over of non-operator by operating construction equipment" (49 or 8.1 percent). The fourth leading cause was "electric shock by equipment contacting power source" (46 or 7.6 percent); the fifth leading cause was "lifting operation" (33 or 5.5 percent); and, the sixth leading cause was "fall from/with ladder" (32 or 5.3 percent). The number and relative frequencies of the remaining causes of the 604 fatal events analyzed may be read directly from Table 1.

Table 2 shows a comparison of the ranks of the causes in 1997 with the average rank of the causes of fatal events during the period 1991 - 1996. It can be seen that the overall rank pattern of the causes in 1997 is very similar to the rank pattern in 1991 - 1996. An overall statistical comparison of the correlation of the rank in 1997 with the average rank in 1991

Table'2. A Comparison of Ranks of Causes of Fatal Events in 1991 - 1996 with 1997

Event	1991 - 1996 Average			1997		
	Number	Percent	Rank	Number	Percent	Rank
1.	5.8	1.0	24	10	1.7	21
2.	5.8	1.0	24	4	0.7	24
3.	26.8	4.6	9	24	4.0	9
4.	7.6	3	4	9	8.1	3
5.	33.3	5.7	5	23	3.8	11
6.	12.8	2.2	18	12	2.0	19
7.	22.8	3.9	10	20	3.3	12
8.	6.2	1.1	23	3	0.5	27
9.	29.5	5.1	7	20	3.3	12
10.	48.8	8.4	2	46	7.6	4
11.	20.2	3.5	12	26	4.3	7
12.	8.2	1.4	22	3	0.5	27
13.	2.3	0.4	29	3	0.5	27
14.	20.7	3.6	11	32	5.3	6
15.	65.3	11.2	1	72	11.9	1
16.	5.0	0.9	26	4	0.7	24
17.	15.7	2.7	15	24	4.0	9
18.	11.5	2.0	20	6	1.0	23
19.	39.7	6.8	4	55	9.1	2
20.	15.7	2.7	15	18	3.0	15
21.	12.4	2.1	19	18	3.0	15
22.	5.0	0.9	26	8	1.3	22
23.	13.7	2.4	17	16	2.6	18
24.	3.0	0.5	28	2	0.3	29
25.	32.7	5.6	6	33	5.5	5
26.	20.2	3.5	12	19	3.1	14
27.	28.8	4.9	8	25	4.1	8
28.	9.5	1.6	21	12	2.0	19
29.	16.7	2.9	14	17	2.8	17
Total	582	100		604	100	

1996 was calculated using a Spearman rank correlation procedure.[2] The correlation obtained was +.93, $p < .0001$, indicating that the ranks of the causes in the two time periods are highly positively correlated, i.e., did not change significantly between 1991 1996 and 1997. Since averaging the 1991-1996 ranks removed inter-year variance, a somewhat lower correlation would be expected between 1996 and 1997 ranks of causes, i.e., a measure of the short-term cycle as opposed to a longer-term trend. However, the Spearman rank correlation between 1996 and 1997 causes was calculated and found to be higher, +.94, $p < .0001$, indicating that the pattern changed even less between 1996 and 1997 (although no statistical significance is inferred).

The correlation result is not surprising given that the general composition of construction output, and therefore the mix of construction operations required to produce the output, was probably very similar during the time periods examined. This interpretation implies that the rank of a cause is a function of the magnitude of exposure to the cause and/or the inherent danger associated with the cause.

It should be noted that the annual rate of fatal events involving accidents on construction sites (inspected by OSHA and reported as of June in the following year) increased between 1991 - 1996 and 1997, averaging 582 fatal events per year in the 1991 - 1996 period and 604 fatal events in 1997, a 3.8 percent increase[3]. However, construction employment increased

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[2]Sidney Siegel, Nonl2arametric Statistics for the Behavioral Sciences (New York: McGrawHill Book Co., Inc., 1956), p.219.

[3]The reader is cautioned not to infer statistical significance to annual increases or decreases in the number of accident-caused fatal events on construction sites for two reasons: (1) the data file supplied to **CRA by OSHA contained only** the fatalities investigated by **OSHA** (but probably not even all of those); and (2) the authors deleted from the data illness fatalities not related to accidents, e.g., heart attacks and seizures, and fatal events involving construction employees but not on construction sites or the contractor's yard, e.g., off-site auto accidents.

during the two periods under study, averaging 4,898(000) in 1991 - 1996 and 5,629(000) in 1997, which means there was a decrease in fatal events per 1000 employees, i.e., .119 in the 1991 - 1996 data and .107 in 1997, a 10.1 percent decrease[4]. However, a comparison of fatal events per 1000 in 1996 (as reported in mid-June of the following year) with 1997 data shows an increase of 1.9 percent.

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[4]Monthly Labor Review, U. S. Department of Labor, Bureau of Labor Statistics, June 1993, June 1994, June 1996 and June 1998.

APPENDIX A

Appendix A: Definition of Causes

1. asphyxiation/inhalation of toxic vapor: lack of oxygen and/or inhalation of toxic gas, (excluding asphyxiation resulting from fire/explosion).

2. caught in stationary equipment: body or clothing caught pulling worker into equipment.

3. collapse of structure: building or other structure falling on worker, not including falling ladder, scaffold, aerial lift/ basket, platform, with a structure, trench collapse, or wall (earthen) collapse.

4. crushed/run-over of non-operator by operating construction equipment: non-operator run-over or crushed between equipment and ground or another object by an operator controlled piece of construction equipment.

5. crushed/run-over/trapped of operator by operating construction equipment: includes rollover and catching of body in equipment or between equipment and ground or other object while operating the equipment.*

6. crushed/run-over by construction equipment during maintenance/ modification: includes equipment/parts falling on worker while assembling or disassembling equipment.

7. crushed/run-over by highway vehicle: any run-over by non-construction equipment.

8. drown, non-lethal fall: non-lethal falls into water and flooding of container, trenches, etc.

9. electrocution by touching exposed wire/source: body part contacting the wire/source except when installing equipment or using a tool.

10. electrocution by equipment contacting wire

    a. ladder
    b. scaffold
    d. crane/lifting equipment/boom/dump truck:
    e. other: contact while handling materials, eg. gutters, iron rods, painting equipment, etc.

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* Includes fatalities resulting from asphyxiation/fire/explosion/drowning of trapped operators.

11. electrocution from equipment installation/tool use: includes failure to deenergize equipment, inappropriate energizing, contacting energized part with tool or body, and inadequately grounded tools or exposed tool wires.

12. electric shock, other and unknown cause

13. elevator (struck/crushed by elevator or counter-weights):

14. fall from/with ladder: includes collapse/fall of ladder.

15. fall from roof; fall through roof: skylight or other opening.

16. fall from vehicle (vehicle/construction equipment): falls from vehicle or equipment while in motion or at rest.

17. fall from/with scaffold: includes collapse/fall of scaffold.

18. fall from/with bucket (aerial lift/basket): includes collapse/fall of bucket.

19. fall from/with structure (other than roof): fall through opening in the side or through the floor (not opening in the floor) and with the structure in a collapse.

20. fall from/with platform catwalk (attached to structure: includes collapse/fall of platform.

21. fall through opening (other than roof): falls through stairwells, equipment openings, or other openings in a floor.

22. fall, other

23. fire/explosion/scalding

24. heat/hypothermia

25. lifting operations: failure of equipment, inappropriate lifting, and all loading and unloading by crane operations except electrocution.

26. struck by falling object/projectile: does not include collapse of structure, trench, earthen wall, or lifting operations.

27. trench collapse: includes earthen wall

28. unloading-loading equipment/material (except by crane): includes slipping and tipping over of equipment/material.

29. other:

    a. lightning
    b. crushed
    c. unknown cause or other

APPENDIX B